equipped with a modem, enabling communication with the outside world via commercial data networks and the Internet. Typically, computer owners use their PCs to send and receive e-mail, to access online services, to participate in electronic commerce and to browse the Internet. The popularity of the Internet is such that there are an estimated 50 million users around the globe. These figures indicate that in the past few years the personal computer has fueled a dramatic increase in data communications and the corresponding demands on the data networks that carry the traffic.

Paragraph beginning on page 2, line 1

The Internet serves as a good example of the increased demands that have been placed on data networks. At first, Internet access consisted of text only data transfers. Recently, with the popularity of the World Wide Web (WWW) and the construction of numerous sites with high quality content, coupled with the development of Internet browsers such as Mosaic, Netscape Navigator and Microsoft Internet Explorer, the use of graphics, audio, video and text has surged on the Internet. While graphics, audio and video make for a much more interesting way to view information as opposed to plain text, bandwidth consumption is significantly higher. A simple background picture with accompanying text requires approximately 10 times the bandwidth needed by text alone. Real-time audio and streaming video typically need even more bandwidth. Because of the increased requirement for bandwidth, activities such as browsing home pages or downloading graphics, audio and video files can take a frustratingly long period of time. Considering that the multimedia rich World Wide Web accounts for more than one quarter of all Internet traffic, it is easy to see why the demand for bandwidth has outpaced the supply. In addition, the creative community is pushing the envelope by offering audio and full motion video on numerous sites to differentiate themselves from the millions of other sites competing for maximum user hits.

Paragraph beginning on page 3, line 10

Today's most popular data access method is POTS. As discussed previously, however, POTS is limited when it comes to large data transfers. An alternative to POTS currently available is Integrated Services Digital Network (ISDN). In the past few years, ISDN has gained momentum as a high-speed option to POTS. ISDN expands data throughput to 64 or 128 Kbps, both from the network to the home and from the home back to the network, and can technically be made available throughout much of the United States and in many other parts of the globe. Similar to POTS, ISDN is a dedicated service, meaning that the user has sole access to the line preventing other ISDN users from sharing the same bandwidth. ISDN is considered an affordable alternative, and in general, ISDN is a much better solution for applications such as Web browsing and basic telecommuting.

However, like POTS, ISDN severely limits applications such as telecommuting with CAD files and full-motion video viewing. The latter requires roughly 39 times the throughput than that provided by ISDN. Multichannel multipoint distribution service (MMDS), a terrestrial microwave wireless delivery system, and direct broadcast satellite (DBS), such as DirecTv and US Satellite Broadcasting (USSB), are wireless networks. They both deliver high bandwidth data streams to the home, referred to as downstream data, but neither has a return channel through which data is sent back over the network, referred to as upstream data. Although it is a relatively affordable system to deploy for broadcast applications, because it requires no cable wires to be laid, it falls short in interactive access. In order to use a wireless system for something as basic as e-mail, an alternate technology such as a telephone line must be used for the upstream communications.

Paragraph beginning on page 4, line 5

Hybrid fiber coax (HFC), a network solution known in the art and currently offered by telephone and cable companies, is yet another option for delivering high bandwidth to consumers. However, HFC has limitations one of which is that HFC networks provide a downstream capacity of approximately 30 Mbps, which can be shared by up to 500 users. Upstream bandwidth is approximately 5 Mbps and also is shared. A disadvantage with HFC is that shared bandwidth and limited upstream capacity become serious bottlenecks when hundreds of users are simultaneously sending and receiving data on the network, with service increasingly impaired as each user tries to access the network.

Paragraph beginning on page 12, line 13

In an example application of the invention, 100BaseS transmission is used on shorter exchange lines when the switch or ONU is located in a serving exchange building. The switch or ONU may be placed in different locations forming different architectures for a hybrid optical network. Some of these architectures include: fiber to the cabinet (FTTCab), fiber to the curb (FTTC), fiber to the node (FTTN), fiber to the building (FTTB) and fiber to the exchange (FTTEx).

Paragraph beginning on page 12, line 19

The 100BaseS transport facility of the present invention supports both LAN and POTS services sharing the same copper distribution cable. The POTS and the LAN services are separated close to the point where the combined signals enter the customer premises. This is achieved by a POTS splitter filter, i.e., splitter/combiner filter, which may or may not be part of the network termination (NT). The 100BaseS system is a point to point transmission system even though the core modem is a blind modem that is able to support point to multipoint communications. The

3

network termination interface at the customer premises can be the widely used 100BaseT RJ-45 interface. The customer can connect any common 100BaseT equipment, such as an Ethernet switch or hub, or any product having an Ethernet network interface card (NIC). The network interface unit will respond to test and management messages originated by any SNMP network management system.

Paragraph beginning on page 12, line 30

The system supports two latency modes that can be modified by software or through network management: (1) with an interleaver resulting in a latency of less than 20 msec or (2) without an interleaver resulting in a latency of less than 200 microseconds.

Paragraph beginning on page 13, line 18

It is also noted that the network comprising computer workstations and the Ethernet hub, shown connected to the access switch in the example in Figure 1, is presented for illustrative purposes only. One skilled in the art can construct numerous other configurations without departing from the spirit and scope of the present invention. The access switch of the present invention can be coupled to any device able to communicate using 100BaseT.

Paragraph beginning on page 13, line 23

Each of the access switches comprises 100BaseS modems that communicate with each other using the 100BaseS modulation and protocol scheme of the present invention disclosed herein. The modems, including the transmitter and receiver portions, incorporated in the access switches are described in more detail hereinbelow.

Paragraph beginning on page 14, line 9

POTS splitters 22 are connected to POTS splitters 24 which are typically physically located in remote locations in different areas of the customer premises. For example, the customer premises may be a large university campus with communication links spanning out to each building within the campus. The communication links carry a combination of 100BaseS and POTS traffic. With reference to Figure 2, the links between the POTS splitters 22 and 24 carry a combined 100BaseS transmission signal in addition to the POTS voice signal. The PBX and the network equipment would typically be installed in the telecommunications equipment room that also serves as the service entrance or network termination point (NTP) to the telco lines from the central office.

Paragraph beginning on page 14, line 21

A block diagram illustrating an optical network unit connected to multiple customer premises via the 100BaseS transport facility is shown in Figure 3. An example central office 150 within the PSTN 110 is shown coupled to an optical network unit (ONU) 152. The fiber is terminated on a high speed switch 154 that comprises a plurality of 100BaseT ports. 100BaseS modems 156, 158 are shown coupled via 100BaseT connections to the high speed switch 154. The 100BaseS modem 156 is coupled to 100BaseS modem 162 within customer premises #1 160. The 100BaseS modem 162, in turn, is connected to the premises distribution network 164. The premises distribution network represents any 100BaseT capable network. Shown coupled to the premises distribution network are computer workstations 166, 168.

Paragraph beginning on page 15, line 15

The MII signal output from the 100Base Tx module 184 is input to a 2 port MII bridge 186. The bridge 186 functions to bidirectionally couple the MII signals from the module to a message memory unit 187 and an MII interface 188. The GT48006 2-Port 10/100 Mbps Ethernet Bridge/Switch Controller manufactured by Galileo Technology, San Jose, California may be used to implement the MII bridge 186. The message memory 187 functions to absorb any differences in data rate between the two sides of the bridge.

Paragraph beginning on page 15, line 21

Date from the MII bridge 186 is input to the MII interface 188. The MII interface 188 is adapted to receive an MII data stream and output a decoded representation of the data that is stored in the flow and rate control memory 189. The function of the flow and rate control memory 189 is to absorb differences in transmitting rates between the 100BaseTX port and the 100BaseS port. The rate difference may be as high as 25 Mbps versus 100 Mbps depending on the number of pairs in use at the 100BaseT and 100BaseS ports. The controller is adapted to manage, administer and control the MII interface and the data splitter 190.

Equation (2) on page 17, line 8

$$\text{downstream baud rate} = \frac{28.125\,\text{Mbps}}{6\,\text{bits/symb}} \qquad (2)$$
$$= 4.6875\,\text{Msymbols/s}$$

Paragraph beginning on page 17, line 20

A block diagram illustrating the transmit portion of the 100BaseS modem of the present invention in more detail is shown in Figure 6. Note that each DSL Ethernet Port card 196 (Figure 4) comprises an independent modem transmitter and receiver. The following description of the modem

transmitter and receiver thus applies to each DSL Ethernet Port card. The data source feeding the modem supplies a transmit data signal and a transmit enable signal to the transmitter interface 80 of the 100BaseS modem. The transmit interface inputs digital data to the frame first in first out (FIFO) 82. The FIFO functions to adjust the rate of data flow between data source and the modem itself. The FIFO compensates for differences in the data rates between the two devices. The output of the FIFO is input to a sync generator 91, header generator 89 and the randomizer 84. The sync generator functions to generate and output two sync bytes to the frame formatter 89. Preferably, the two sync bytes are F6H and 28H. The header generator functions to generate header information that typically spans a plurality of bytes. The header itself is then randomized or scrambled by randomizer 90 and subsequently encoded by encoder 92. The output of the encoder is input to the frame formatter 89.

Paragraph beginning on page 10, line 16

The transmitted power output by the system onto the twisted pair wire is preferably limited to 10 dBm (10 mW) in each direction. This power limit is widely incorporated into existing standards such as ANSI and ETSI. The transmit power is limited in order to better control the power spectral density (PSD) on the wire. The downstream power is thus fixed but the power transmitted on the upstream direction is controlled by the downstream link in accordance with the length of the wire so as to maintain the received power in the upstream direction at a constant level. Transmit power control is necessary in order to prevent excessive far end crosstalk to other upstream channels.

In the Abstract

A facility transport system for transporting high speed Ethernet data over digital subscriber lines. The system, referred to as 100BaseS, is capable of transmitting 100 Mbps Ethernet over existing copper infrastructure up to distances of approximately 400 meters. The system achieves bit rates from 25 to 100 Mbps in increments of 25 Mbps with each 25 Mbps increment utilizing a separate copper wire pair. Each pair used provides a bidirectional 25 Mbps link with four copper wire pair connections providing 4 x 25 Mbps downstream channels and 4 x 25 Mbps upstream channels. The system utilizes framing circuitry to adapt the 100BaseT input data signal to up to four separate output signals. A DSL Ethernet Port card couples the modem to each twisted pair used. Each DSL Ethernet Port card comprises modem transmitter and receiver circuitry for sending and receiving 100BaseS signals onto twisted pair wires. The system utilizes QAM in combination with frequency division multiplexing (FDM) to separate downstream channels from upstream channels and to separate both the downstream and the upstream channels from POTS and ISDN signals.